

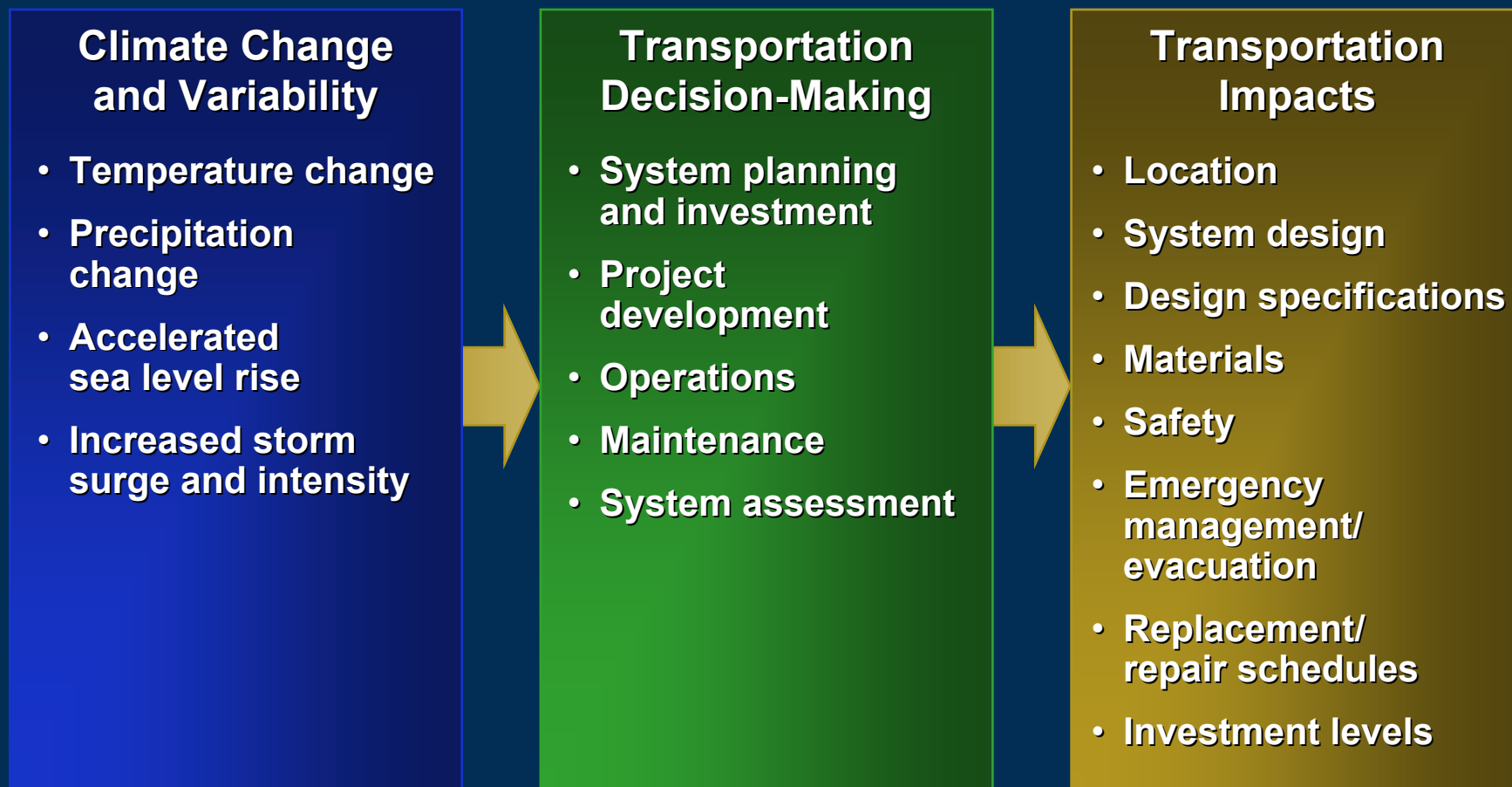
Potential Impacts of Climate Change and Variability on Transportation Systems and Infrastructure – *The Gulf Coast Study*

North Carolina Briefing
March 5, 2008

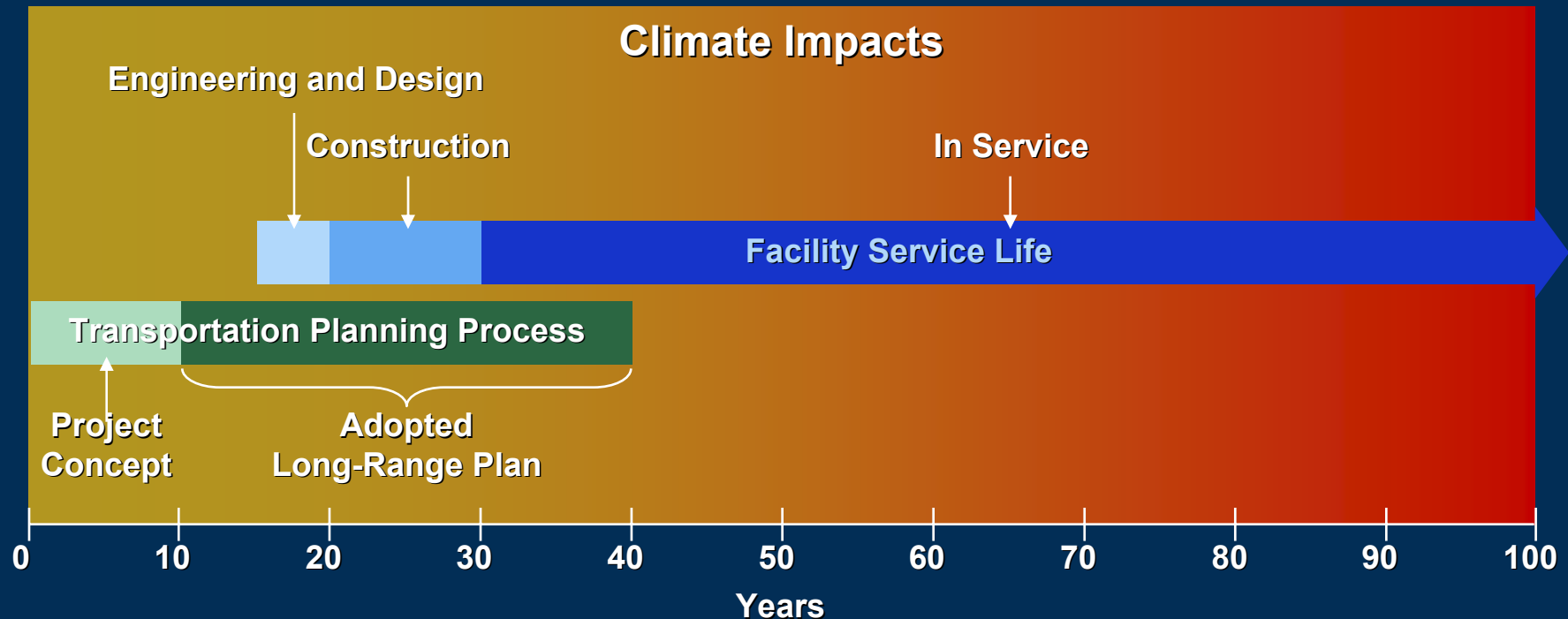
Mike Savonis
Team Leader for Air Quality
FHWA



How Will Climate Change Affect Transportation Decisions?



Transportation Timeframes vs. Climate Impacts



U.S. DOT / USGS Gulf Coast Study

Potential Impacts of Climate Change and Variability on Transportation Systems and Infrastructure



Overall Climate Impacts - Key Drivers for Analysis

- Accelerated relative sea level rise
- Increased storm surge and storm intensity
- Changes in temperature
- Changes in precipitation



***Draft Results* – Gulf Coast Study**

Trends in Climate and the Natural Environment

- **Average temperature is likely to increase by 2°- 4° F by 2050**
 - **More hot days: Extreme daily high temps will also increase**
- **Models show mixed results for changes in average precipitation**
 - **Intensity of rainfall events, however, will likely increase**
- **The magnitude of impacts worsen as emissions increase under the IPCC scenarios**



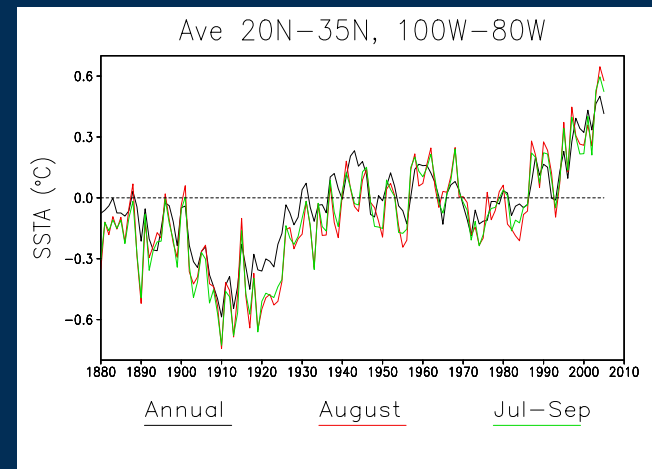
Houston, TX

Draft Results – Gulf Coast Study

Trends in Climate and the Natural Environment

- **Relative sea level will likely increase 1 to 6 feet**
 - Massive inundation due to relative sea level rise
 - Relative sea level includes:
 - Climate-induced impacts of thermal expansion and ice melt;
and
 - Sinking land masses (subsidence) in the central Gulf Coast
- **Hurricane vulnerability is high today and may worsen**
 - Increase in storm intensity is likely

Sea surface temperature trend in the Gulf of Mexico region (Source: Smith and Reynolds 2004)



Land Surface Elevations Subject to Flooding in the Study Area
under High, Mid, and Low Sea Level rise Scenarios (Ensemble of 7 GCMs under
Four Emission Scenarios) (SLRRP Model results in centimeters)

Year 2050	Low				Year 2100	Low			
	A1FI	B1	A1B	A2		A1FI	B1	A1B	A2
Galveston, Texas	83.0	80.9	83.4	83.4	Galveston, Texas	130.7	117.0	124.9	127.0
Grand Isle, Louisiana	107.5	106.0	108.8	106.3	Grand Isle, Louisiana	171.2	159.7	168.7	167.6
Pensacola, Florida	48.0	47.8	48.4	53.7	Pensacola, Florida	83.9	70.1	78.2	75.2
Year 2050	Mid				Year 2100	Mid			
	A1FI	B1	A1B	A2		A1FI	B1	A1B	A2
Galveston, Texas	88.9	86.7	88.7	88.8	Galveston, Texas	146.0	129.5	137.1	140.8
Grand Isle, Louisiana	113.6	111.8	114.2	111.8	Grand Isle, Louisiana	185.3	171.4	180.2	181.3
Pensacola, Florida	53.9	53.6	53.7	60.0	Pensacola, Florida	99.2	82.6	90.3	89.3
Year 2050	High				Year 2100	High			
	A1FI	B1	A1B	A2		A1FI	B1	A1B	A2
Galveston, Texas	94.8	92.5	93.9	94.3	Galveston, Texas	161.3	142.0	149.3	154.5
Grand Isle, Louisiana	119.6	117.6	119.6	117.3	Grand Isle, Louisiana	199.6	183.1	191.7	195.1
Pensacola, Florida	59.8	59.4	58.9	66.3	Pensacola, Florida	114.5	95.0	102.5	103.5

Draft Results – Gulf Coast Study

Trends in Climate and the Natural Environment

- The central Gulf Coast is particularly vulnerable to climate change over the next 50-100 years
- Climate change impacts need to be integrated with other coastal / environmental effects
- The timing of impacts is not clear; abrupt change cannot be ruled out



Draft Results - Gulf Coast Study

Vulnerability Due to...**Relative Sea-Level Rise**

- **Relative sea level rise (due to climate change and subsidence) of 4 feet could permanently flood:**
 - ✓ **24% of interstate miles, 28% of arterial miles, New Orleans Transit**
 - ✓ **72% of freight / 73% of non-freight facilities at ports**
 - ✓ **9% of the rail miles operated, 20% of the freight facilities, no passenger stations**
 - ✓ **3 airports**
 - ✓ **Temporary flooding in low-lying areas due to increased heavy downpours will broaden affected areas**



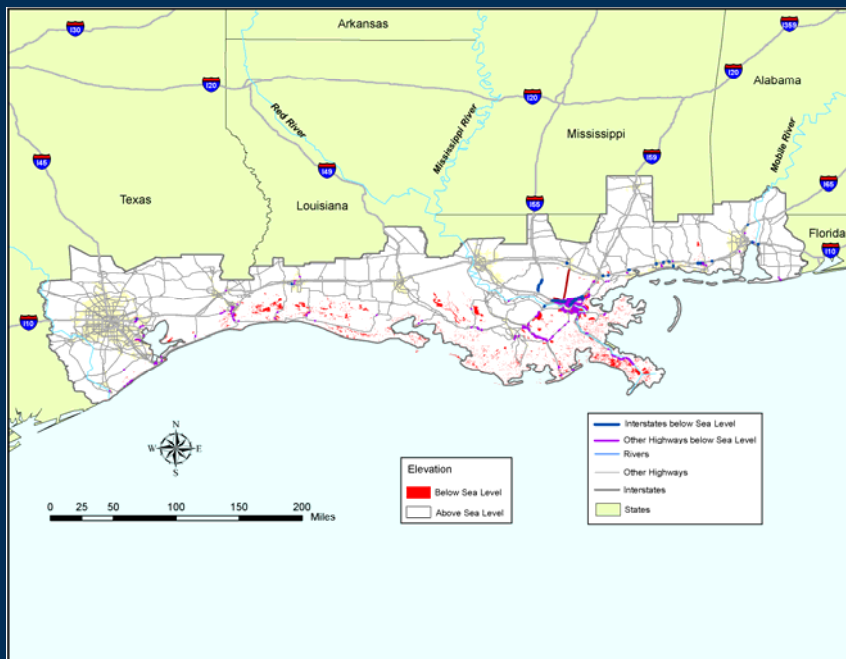
SAP 4.7



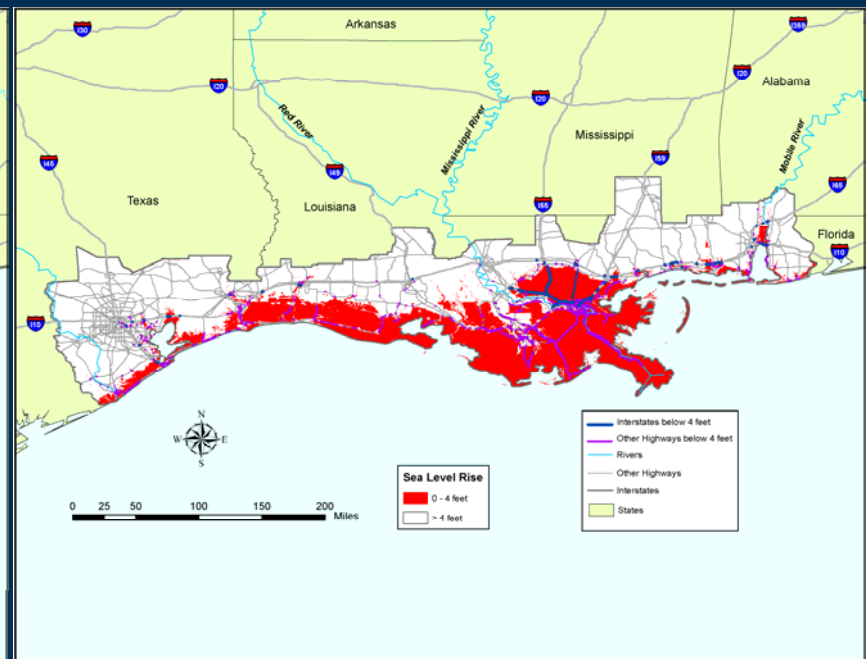
Draft Results – Gulf Coast Study

Highways Vulnerable to Relative Sea Level Rise

Baseline (Present Day)



4 Feet of Sea Level Rise



Draft Results –Gulf Coast Study Vulnerability Due to...**Storm Surge**

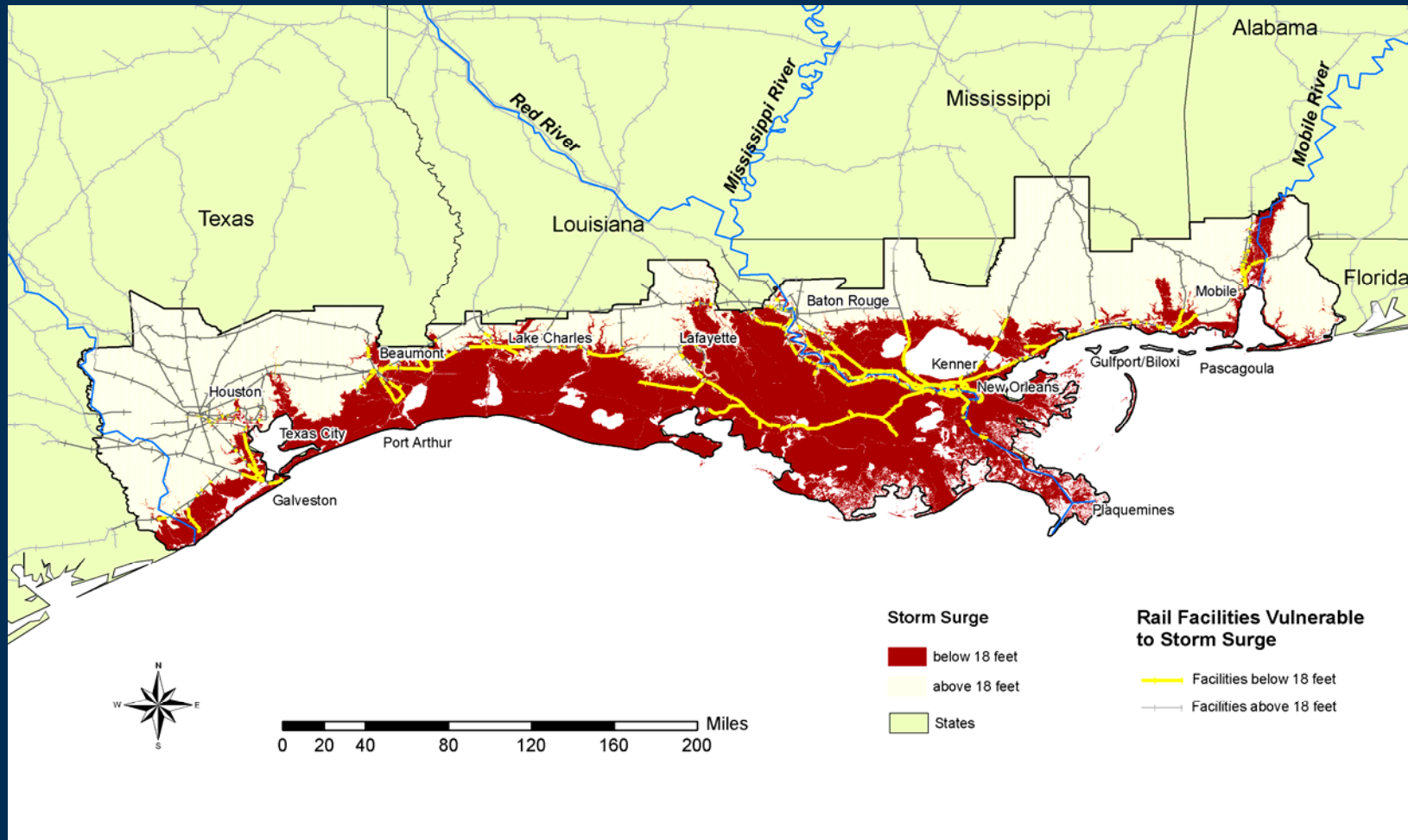
- **Transportation infrastructure that is vulnerable to 18 feet of storm surge includes:**
 - ✓ **51% of interstate miles, 56% of arterial miles, and most transit authorities**
 - ✓ **98% of port facilities vulnerable to surge and 100% to wind**
 - ✓ **33% of rail miles operated, 43% of freight facilities**
 - ✓ **22 airports in the study area at or below 18 feet MSL**
 - ✓ **Potentially significant damage to offshore facilities**

Hurricane Katrina Damage to Highway 90 at Bay St. Louis, MS



Source: NASA Remote Sensing Tutorial.

Freight Rail Lines Potentially Vulnerable to Storm Surge of 18 feet



Draft Results – Gulf Coast Study

Vulnerability Due to...**Temperature increases**

- **As temperatures increase, operations will be affected:**
 - **Potential change in maintenance and construction practices**
 - **Increased use of energy for refrigerated storage**
 - **Potential rise in rail buckling**
 - **May result in impacts to aircraft performance and runway utilization**

Draft Results – Gulf Coast Study Transportation Planning

- Climate change is rarely considered today, but the longevity of infrastructure argues for its integration
- Current practice focusing on a 20-year time frame is not well-suited to the assessment of impacts due to the natural environment
- It is useful to examine the vulnerability of the intermodal system in addition to specific facilities



SAP 4.7



The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure (NC): 6 cm



The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure (NC): 6 cm

NC State Statistics		6 cm					
Increase in Eustatic SLR		Regular Inundation				Total	
Length		Km	% Affected	Km	% Affected	Km	% Affected
Interstates		0.9	0%	1.5	0%	2.4	0%
Non-Interstate Principal Arterials		112.9	2%	231.6	3%	344.6	5%
NHS Minor Arterials		180.9	4%	161.7	3%	342.6	7%
National Highway System (NHS)		256.5	4%	338.7	5%	595.2	8%
Rails		86.2	1%	258.7	3%	344.8	4%
Area		Acres	% Affected	Acres	% Affected	Acres	% Affected
Ports		225	49%	167	36%	392	85%
Airport Property		635	2%	3,238	9%	3,873	11%
Airport Runways		44	2%	237	8%	281	10%
Total Land Area Affected		1,682,708	5%	1,466,079	5%	3,148,787	10%



The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure (NC): 48.5 cm

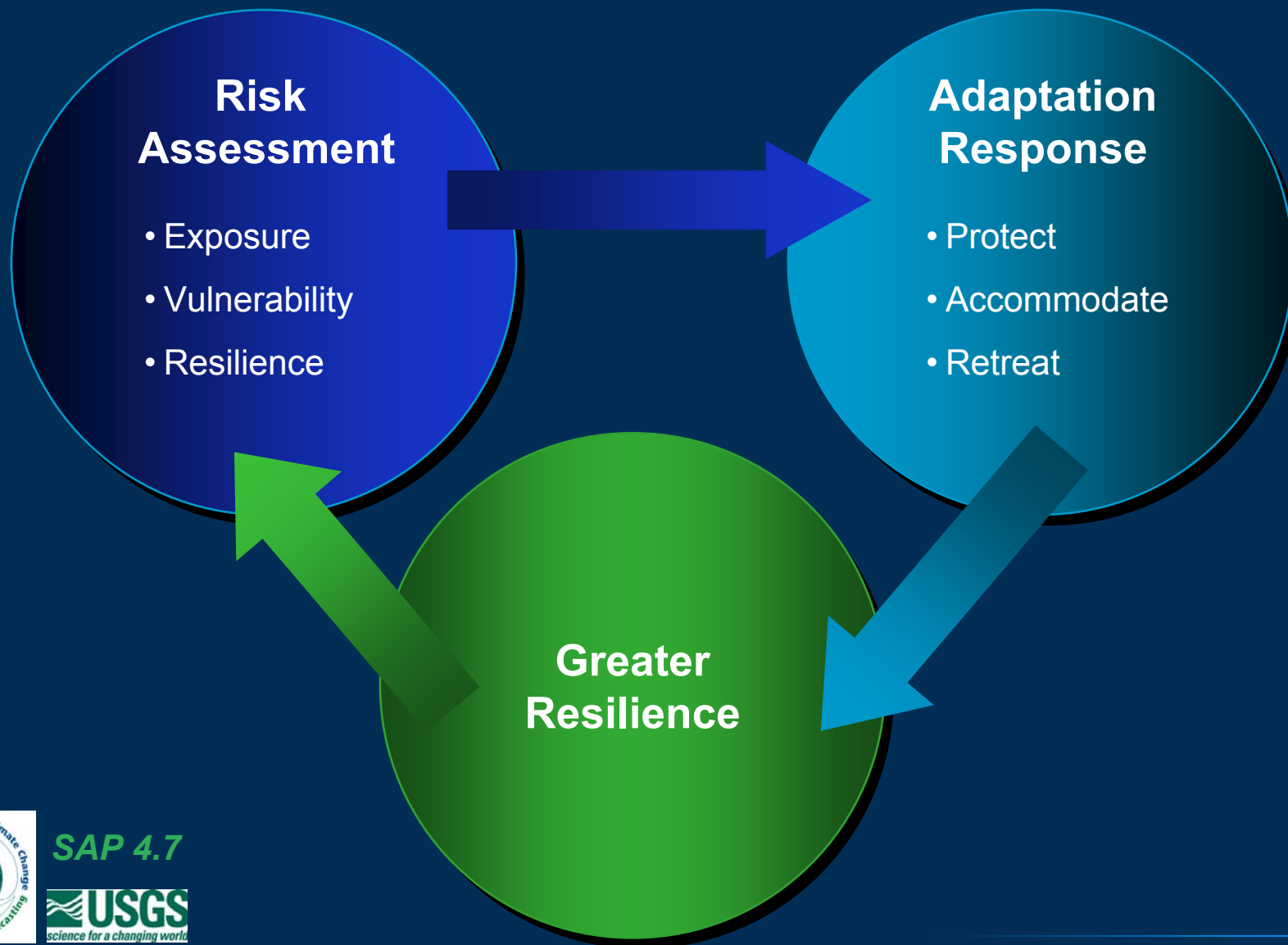


The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure (NC): 48.5 cm

NC State Statistics		48.5 cm				
Increase in Eustatic SLR		Regular Inundation		At-Risk		Total
Length	Km	% Affected	Km	% Affected	Km	% Affected
Interstates	1.4	0%	7.3	0%	8.7	1%
Non-Interstate Principal Arterials	201.8	3%	218.1	3%	419.9	6%
NHS Minor Arterials	279.9	6%	90.6	2%	370.5	8%
National Highway System (NHS)	419.5	6%	263.0	4%	682.6	10%
Rails	193.8	2%	218.1	3%	411.8	5%
Area	Acres	% Affected	Acres	% Affected	Acres	% Affected
Ports	320	70%	118	26%	439	95%
Airport Property	2,015	5%	2,276	6%	4,291	12%
Airport Runways	132	5%	191	7%	323	12%
Total Land Area Affected	2,341,767	7%	1,149,723	4%	3,491,490	11%



A Risk Assessment Approach to Transportation Decisions



Gulf Coast Study: **Next Steps**

